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Special Bulletin

Number Two

Sanitary Apparatus for the Disposal of Excreta and Sewage From Private Residence and Isolated Houses

— BY —

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1. **The Question Stated.** The question of disposing of the waste materials from the human system so that they will not be a menace to our health is one of grave importance and surely deserves a great deal of consideration, not only from cities and thickly populated communities, but also from those people who live in the smaller towns and villages, and even from the man, or family, that is more or less isolated. This question is well in keeping with the modern tendencies toward a better and more scientific life, better health and higher living. Scientific disposal of human excreta means scientific disposal of typhoid and other diseases, for it is a fact of this era that deaths from infected water are becoming fewer as sanitary science is being heeded more.

2. The excretions from the kidneys and the waste materials of digestion, after they leave the body, putrify accompanied by noxious odors, but this excreta is also filled with living organisms, or bacteria, which find the most favorable conditions for multiplication in the digestive tract. Many of these organisms are harmless, but the germs of typhoid fever, dysentery, cholera or other intestinal maladays may be present and in consequence, the method of disposal of all body excreta should be of such a nature that there is no possibility of it contaminating drinking water, or food, or any substance that is used about the mouth or internally.

(3). Under the most primitive conditions excretal matter is deposited directly upon the earth or possibly in streams. A slight advance in this condition is found in the common privy, with its accompanying vault or pit for the collection of excreta. This is without doubt a most objectionable contrivance. Quantities of decomposing and noxious human excreta are stored up in a more or less porous pit, or even in a mass directly on the surface of the ground, freely exposed to the distributing agency of flies and possibly some of the higher animals. The liquids leach into the surrounding soil, and if the solid matter is removed at intervals, the handling causes a fresh menace to health.

4. Since it is practically impossible for all to have a pressure water supply system and by this means secure the prompt removal of excreta, the only thing to do is to minimize, as far as possible, the dangers which lurk in the careless handling and improper disposal of the waste materials of the human body.

SANITARY DISPOSAL WHEN THERE IS NO PRESSURE WATER SUPPLY SYSTEM AVAILABLE.

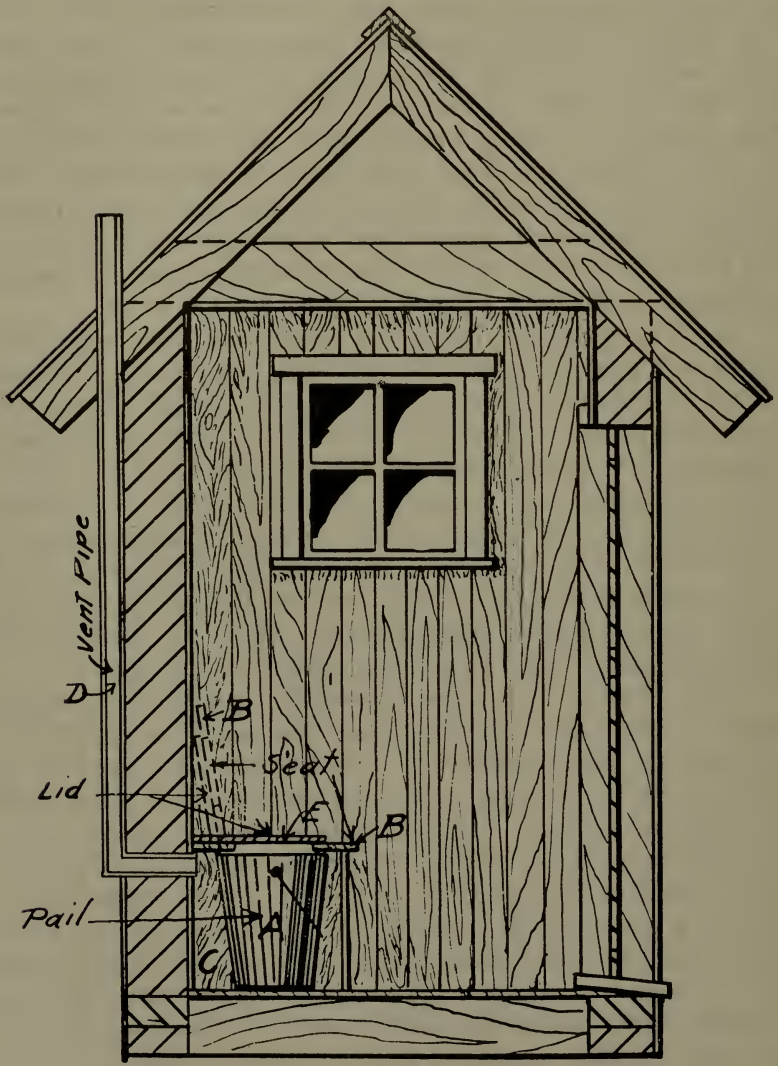


Fig. 1.

5. **The Dry System.** Fig. 1 shows diagrammatically a method of collecting human excreta by what is called the dry

system. As the name suggests, the manner of collecting consists in using a water tight container and some dry, powdered substance to absorb the watery matter and cover the more solid substances that are deposited. The sketch shows a pail, or tank (A), placed under the seat (B) in the fly-proof box (C), which is ventilated through the pipe (D). The collecting vessel (A) should be round, since this form is easily cleaned, and made of metal, or possibly water tight, reinforced concrete. The seat has a close-fitting lid, or cover (E), which should always be closed when the closet is not in use, or better still, be so arranged that it will not stay open except when held by a person using the seat. The seat (B) is hinged so that it may be raised to the position shown by the dotted lines to provide for the removal of the vessel (A). This allows the building to be completely inclosed, and even sealed on the inside if desired, as the sketch shows. Such an arrangement permits of artificial heat in cold weather by means of a small coal oil stove or lantern, and tends to do away with the dread which a person experiences when the demands of nature require a visit to an out-door privy in cold weather. A ventilator, composed of a twelve-inch square or circular opening, well screened with wire mosquito netting, should be placed over the door, or in one end of the building near the top, and another, smaller one of six-inch size, also screened, should be built into the side or end of the box (C), which contains the pail or tank. If desired a hinged door can be placed at the rear of the box (C) for removing the pail (A) from the outside, and the seat (B) fastened firmly down.

6. **Deodorizer for the Dry System.** Clay or loam, if finely pulverized, each rank high as deodorizers for use in dry closets. During the dry summer months great quantities of dust are found on any unimproved country road and this can be collected and stored in sacks or barrels and makes an excellent deodorizer for dry closets. Ashes, especially wood ashes, are much used as deodorizers and give fair satisfaction. Lime and charcoal are also used, but the expense of each is a drawback that tends to prevent their use in many cases. The deodorizer should be applied each time the closet is used. The easiest method of applying is by

means of a scoop, or small shovel, the substance being kept in a box, placed in a convenient position in the closet.

7. **Disposal of Contents of the Pails.** It is probably not advisable to construct a pail that will hold more than two or three days deposits from the people of an ordinary household, and therefore the mixture of excreta and earth will have to be removed often and its disposal becomes a problem. The following methods are in use although some of them are dangerous and unsanitary, as explained.

8. **Burning.** The placing of the dry closet contents in a fire and thoroughly consuming all organic matter is an absolutely safe method of disposal but oftentimes expensive and laborious.

9. **Disinfecting.** Treating with a solution, composed of one-eigth of a pound of chloride of lime, (ordinary bleaching powder) to one-half gallon of water, for fifteen or twenty minutes, and then burying, is an excellent method of disposal. The night soil mixture is completely mixed with the disinfecting solution and allowed to stand for the above stated time after which it is dumped into a pit and covered with soil. The solution should be made up fresh whenever it is desired to use it and is best made by first adding just enough water to the powder so that it can be worked into a paste, and after mixing until smooth, adding the required amount of water and stirring until a solution has been formed.

10. **Burying.** The burying of the night soil is a fairly safe method of disposal if care is used in selecting ground for this purpose, where contamination can do no harm. The writer knows of a case of disposal of night soil for a family of four, that has been carried on by this method for twenty years. The mixture is carefully buried under six to twelve inches of soil on a plot of ground that is well underdrained with a system of agricultural tile, and no trouble whatever has been caused.

11. **Using as a Fertilizer.** The use of this mixture as a fertilizer is not a good practice and is forbidden by some states.

12. **Mixing With Manure.** The mixing of the night soil with manure is also dangerous.

13. **Heaping on the Ground.** The piling of the mixture on the ground is especially dangerous and should never be permitted.

14. **Depositing in Streams.** The throwing of the night soil into streams or ponds is very bad practice and is probably the most unsanitary method of disposal that can be imagined.

15. Dry sewage systems are imperfect from the sanitary point of view, although they are a big improvement over the common privy. The efficiency of the system depends on the co-operation of all persons using it, for one of the first essentials of the system is the careful covering of all the excrement with the deodorizer. There must also be an effective system of removing and handling the night soil, and for the final disposal of the mixture.

16. **The Wet System.** The equipment required for the wet system is the same as in the dry system, the only difference being that in this system some liquid is placed in the pail, or tank, and no deodorizer is used. When the pail is placed in position it is filled about one-fourth full of water and half a cup of coal oil is poured on its top to act as a fly repellant.

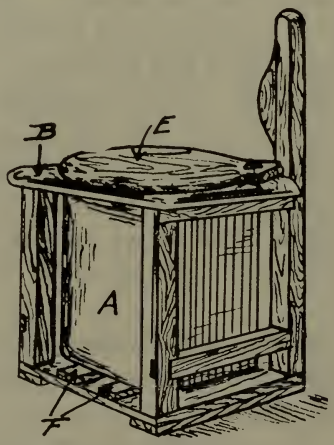
17. **Disposal of the Wet System Mixture.** When the pail is full it is removed and its contents are disposed of in one of the following ways:

18. **Heating.** The mixture can be heated to a temperature of 212 degrees or boiled and then buried or used as a fertilizer.

19. **Liquifying.** The mixture can be placed in a covered barrel or vat and allowed to ferment for not less than a week. It should then be disinfected by pouring into one barrel of the mixture, one gallon of disinfectant, made from bleaching powder as explained in paragraph (9). The material should then be buried, or discharged into a line of three-inch open joint tile, or a wooden box drain, open at the bottom and about three inches deep, either being placed about sixteen inches under ground and surrounded with gravel. Such a drain should be about seventy-five feet long if one barrel of effluent is to be discharged into it at one time. If any effluent appears on the surface after the discharge into the drain the length of the same should be in-

creased until nothing shows on the top of the ground. The vat or barrel can be so arranged that the removal of a plug will drain it into the tile, but a screen, having about three-eighth inch openings, should be placed over the end of the tile to prevent any solid material from entering and clogging the drain.

20. The wet system has disadvantages in that it must be frequently cleaned and the collected material removed and disposed of. The danger of spilling when the pail is removed is greater than in the dry system, and splashing causes more or less trouble when the privy is being used unless the pail is made rather deep.



Sanitary Pail
FIG. 2

21. **Sanitary Pail.** Fig. 2 shows a new design of sanitary pail for use either as a dry system or wet system closet, as found in the Public Health Reports of the United States Public Health Service, Vol. 28, No. 30. The tank (A) is made from a Standard Oil Co's. five gallon container, by cutting out the top. It slides under the seat (B) on the strips (F), which are adjustable so that the pail can be raised to a close fit against the under side of the seat. The cover, or lid (E) is so arranged that it is self-closing. The frame is made of 2" x 2" and 1" x 3" lumber and is entirely open. The seat and cover are made of 1¼" boards. This apparatus is light, easily moved about, and can be used as a

commode in a sick room if desired. From a sanitary point of view it is safe to use anywhere.

22. **The L. R. S. Privy.** Instead of using a pail in the wet system, which has to be removed and its contents placed in a vat for liquifying, the vat or barrel can be placed under the seat of the privy and the liquifying action carried on in it. Farmers Bulletin No. 463 of the U. S. Department of Agriculture describes a very efficient syle of this form of sanitary closet known as the L. R. S. privy. According to the bulletin this apparatus consists of the following parts:

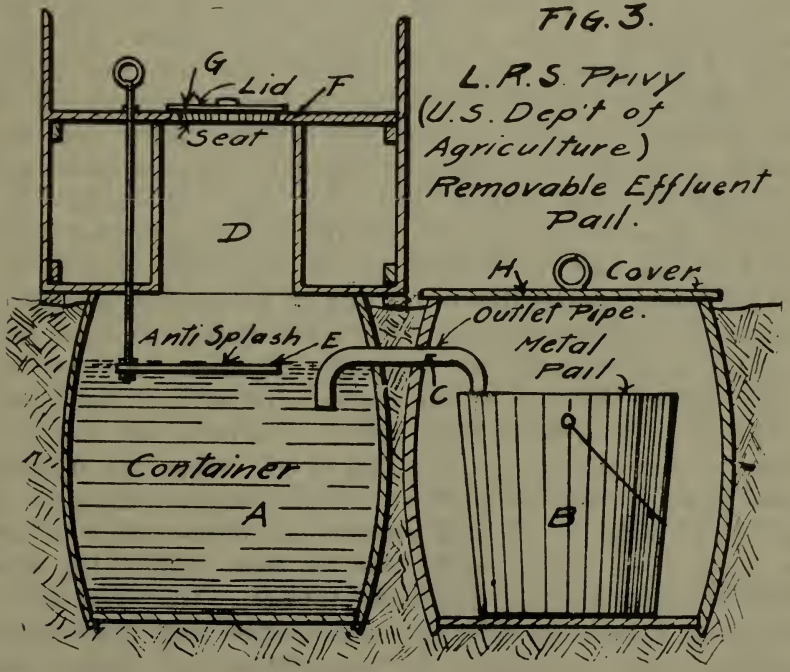


FIG. 3.
L.R.S. Privy
(U.S. Dep't of
Agriculture)
Removable Effluent
Pail.

23. (A) A water tight can, barrel or other container to receive and liquify the excreta. Fig. 3.

24. (B) A covered, water tight can, barrel or other vessel to receive the effluent of overflow from (A).

25. (C) A connecting pipe.

26. (D) A tight box, preferably zinc lined, which fits tightly over the top of the liquifying vat (A). It is provided with an opening at the top for a seat, and this is covered with an automatically closing lid.

27. (E) An anti-splashing device, consisting of a small board, placed horizontally under the seat, about one inch below the level of the liquid. It is held in place by a rod which passes through eyes or rings fastened to a box, and by which the board is lowered.

28. The liqifying tank is filled with water up to the point where it begins to trickle into the effluent tank. As an insect repellant a thin layer of some form of petroleum may be poured on the surface of the liquid in each tank.

29. **Practical Working of the L. R. S. Privy.** When the privy is to be used, the rod is pulled up so that the anti-splashing device is about one inch below the surface of the liquid. The fecal matter falls into the water, but the board prevents splashing and thus overcomes one of the greatest objections to the wet system. After use, the person sinks the anti-splashing board by pushing down the rod and the fecal matter floats free into the liquid. Although some of the fecal matter floats it is protected from fly breeding and fly feeding by the automatic closing lid, by the liquid, by the film of oil, and by having the apparatus placed in a screened place. The solid matter becomes fermented in the liquid and gradually liquifies. As the excreta settles the level of the liquid is raised and the liquid flows into the effluent tank, where it is protected from insects by a tight cover or by a film of oil. When the effluent tank is full it may be emptied and the contents disposed of as discussed later. In cold weather the fermentation is not so rapid as in warm weather and on that account the contents of the tank may gradually thicken. The evaporation will vary greatly in different communities and at different seasons, and the greater the evaporation the thicker the material in the liquifying tank becomes. To overcome this thickening water should be added to the liquifying tank as required. If this type of privy is managed fairly intelligently, the indications are that the liquifying tank will rarely need cleaning, probably not oftener than once in several years, and even then cleaning can be accomplished by simply adding water to the liquifying tank, and stirring up the contents until it is carried over into the effluent tank, where it should be caught and removed and afterward treated with a disinfecting solution, about one gallon of dis-

infectant, made as described in paragraph (9), to one barrel of effluent. Only the regular, thin toilet paper should be used in these privies as it is easily liquified.

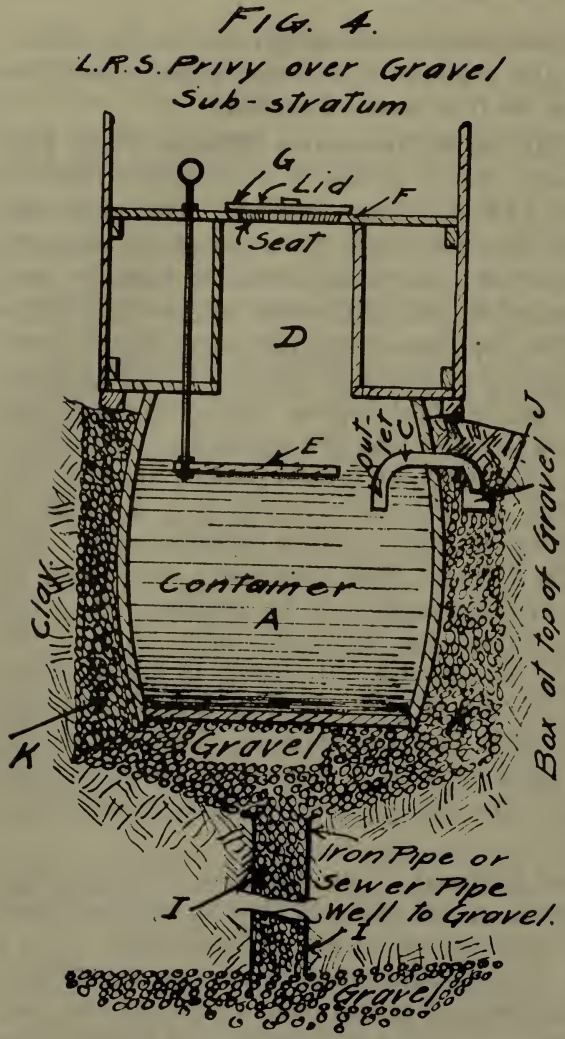
30. **L. R. S. Privy With Removable Effluent Tank.** Fig. 3 shows a diagramatic sketch of the L. R. S. privy built so that the container (A) is under ground. The container shown is a barrel, but one built of water-proof concrete would probably be better. A second barrel or tank is used to hold the movable pail or can (B) which receives the effluent. (C) represents the connecting pipe and should have its end below the surface of the liquid in the liquifying tank, a distance of from six to eight inches. (D) represents the tight box on top of which the seat (F) is placed. (E) shows the anti-splashing device with its handle passing through the seat. (G) represents a tight cover or lid over the hole in the seat and is preferably made to close automatically. (H) is the cover for the effluent tank container, which can be removed when the effluent tank is to be emptied. It is not necessary to place either the liquifying tank (A) or the effluent tank (B) under ground. However, if placed above ground a tight box should be made to hold the effluent pail (B) as a protection from flies and animals. This box should be provided with some kind of a removable cover so that access can be had to the effluent pail when it is necessary to empty it.

31. **Disposal of Effluent.** The following ways are suggested for the disposal of the effluent that is removed from the L. R. S. privy with the removable effluent pail.

32. **Heating.** If a metallic vessel is used as the effluent tank it may be removed and placed over a fire and the contents heated to a temperature of 212 degrees, or boiled, after which it can be used for fertilizing purposes.

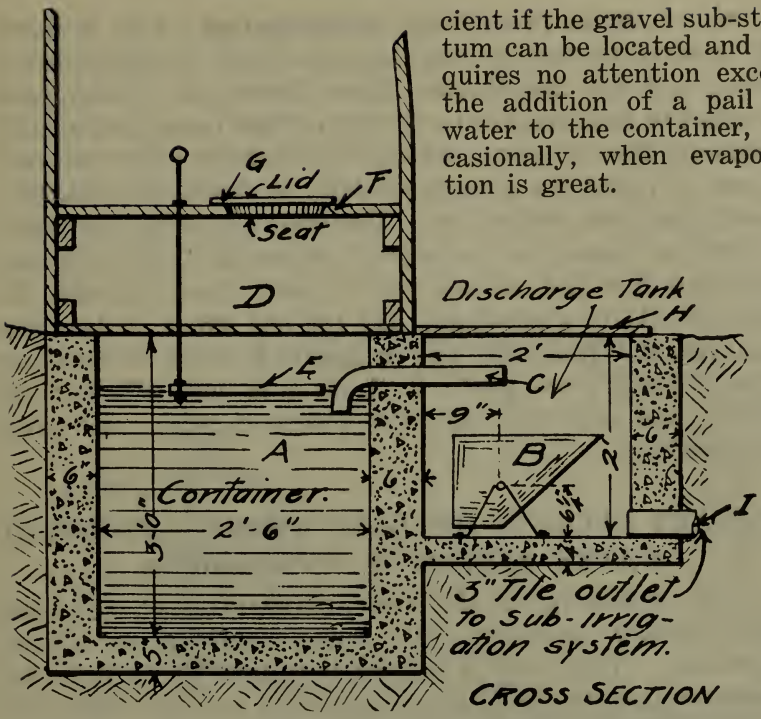
33. **Disinfecting.** The effluent can be treated with a disinfectant, made as explained in Paragraph (9). About one gallon of the chloride of lime solution being used to one barrel of the mixture. After this treatment has been carried on for about twenty minutes the substance can be used as a fertilizer or it can be buried.

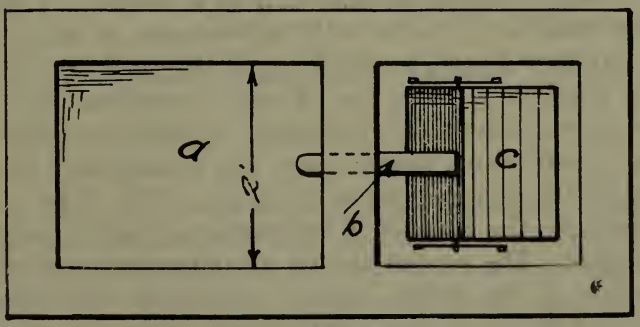
34. **Emptying Into Sewers** In partially sewered towns, or wherever sewers are available, this effluent may be emptied directly into them.

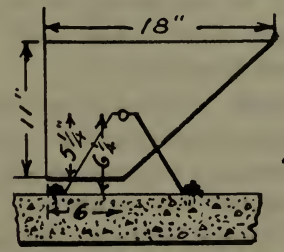


35.. **L. R. S. Privy Over a a Gravel Sub-Stratum.** Fig. 4 shows an L. R. S. Privy that can be used to advantage where there is a stratum or bed of gravel beneath the surface but not at too great a depth. The letters, (A), (C), (D), (E), (F), and (G) have the same designations as in paragraph (30). (I) represents a well, drilled to gravel and lined with iron, or sewer pipe, about four or six inches in diameter. This pipe or well is filled with crushed stone or gravel. A hole or pit (K) is dug at the top of this well and partly filled with gravel or crushed stone, and the container (A), consisting of a portion of a barrel, or a metal or concrete tank is placed in this rocky material. (C) is the outlet pipe, which discharges into the drain (J), which is built of flat stones, concrete or agricultural tile. It should extend around the top of the gravel in the pit and have openings in its side and bottom for discharging the effluent. In an installation of this kind great care must be taken, that the flow of the underground water is from the well, which is used for drinking water purposes, toward the well that is the outlet for the L. R. S. privy, and not from the privy toward any well that is used for a water supply, which is closer than one mile, as the gravel might not purify the effluent and the contamination of the well result. This system is very effi-

cient if the gravel sub-stratum can be located and requires no attention except the addition of a pail of water to the container, occasionally, when evaporation is great.







L.R.S. PRIVY. with Sub-irrigation.

FIG. 5

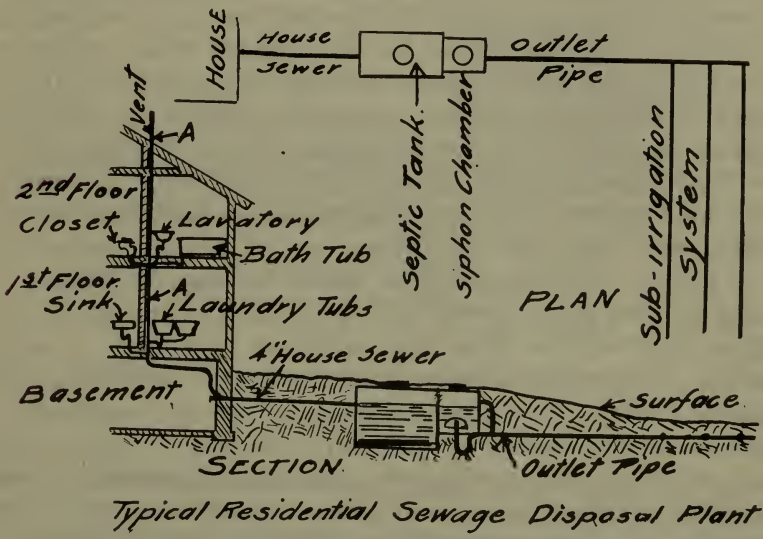
36. **L. R. S. Privy With Sub-Irrigation.** Fig. 5 shows still another method of utilizing the L. R. S. principle, as worked out by the Kansas State Board of Health, and described in Bulletin No. 10, Vol. 9, of that organization. (A) represents the container, which discharges through the outlet pipe (C) into the tipping effluent, or discharge tank (B), which is set in a concrete pit. The tank (B), which is shown in detail, is hinged so that when it is nearly full it tilts and discharges into the pit and the effluent flows through the outlet tile (I) to a sub-drain, like the one which is described in paragraph (19). The sub-irrigation method of disposing of the effluent from the L. R. S. privy is very efficient and sanitary and requires very little attention when once properly working.

SANITARY EXCRETA DISPOSAL WHERE A PRESSURE WATER SYSTEM IS AVAILABLLE.

37. In this age of efficiency, standardization and labor saving devices, pressure water supply systems are almost a necessity. With such a system it is possible to have hot running water, as well as cold, right at the sink, bath tub or laundry tray, available at the turn of a faucet. A drain carries away all liquid wastes with a minimum of labor and an inside, sanitary closet, available at all times of the day or night, is a possibility. The use of such apparatus satisfies one of the principal axioms, recognized in sanitary sewerage design and construction, namely that the sewage and all the sewage must be removed without delay. This first principal is solely for the benefit of the person or family producing the sewage. The second is just as important and is for the protection of the public health. It is that the sewage be so disposed of as to lose permanently its power of evil. If this last law is followed it will be necessary to find some method of disposing of the sewage after it has been carried away from the house where it was produced.

38. **Cess Pools, A Poor System.** For a long time cess pools were considered to be the only method of caring for sewage where large running streams were not available, or where, due to the efforts of the authorities to prevent stream polution, the discharge of sewage into streams in the untreated state is forbidden. A cess pool, even if it is tight and

closed at the top, possesses drawbacks, one of which is the disposing and handling of its contents at the time of cleaning. If it is not water tight the liquids penetrate the sur rounding soil, which may be composed of suitable sand or gravel to purify it. If, however, the soil is clayey or rocky, and traversed by fissures or openings, a cess pool becomes a dangerous menace to health, and the purity of wells even at a distance.



Typical Residential Sewage Disposal Plant

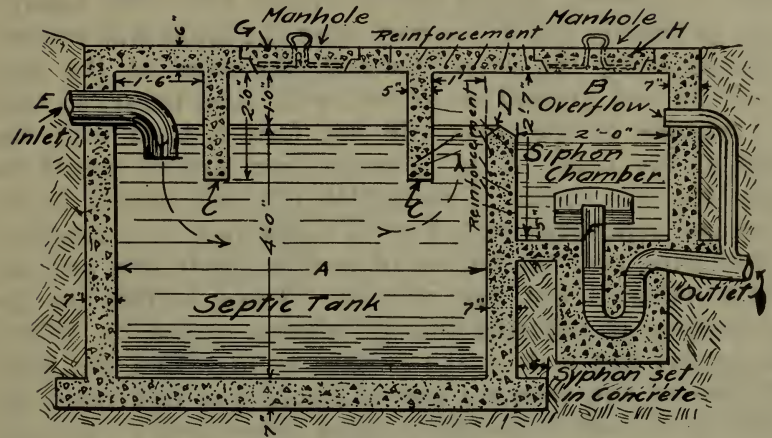
FIG. 6

39. **A Good Private House Sewerage System.** Fig 6 shows a typical plan and section of a sewerage system for a private house. The second floor contains the closet, connected by a 4", iron soil pipe to a 4", iron soil and drain stack (A), also the lavatory and bath tub, which discharge through 1¼" or 1½", trapped iron, brass or lead, drain pipes into the 4", iron stack (A). This stack extends from the basement up through the roof and is open at the top for ventilating purposes. The kitchen sink and two laundry tubs are shown on the first floor. These also drain into the stack (A) through iron or lead drains, 1¼" or 1½" in diameter. The soil or drain stack (A) connects at the basement wall with a 4" vitrified pipe sewer, laid with carefully cemented joints on a grade of not less than one foot to the hundred

feet, and extending from the basement wall to the septic tank. The siphon chamber is just beyond the septic tank and contains the siphon. From this chamber a four-inch vitrified pipe sewer, laid with carefully cemented joints of a grade of not less than one foot to the hundred feet, extends to a sub-irrigation system.

40. **Septic Action Explained.** The septic tank, in connection with some form of final treatment, such as sub-irrigation or filtration, is probably the best means of solving the problem of sewage disposal for the isolated home, which requires a private plant. House sewage is principally water in which is mixed possibly one table-spoon full to the barrel of animal, vegetable and mineral matter, some of it possibly in the liquid state, but the most of it in the form of solid, or semi-solid matter. The mineral matter is harmless but the animal and vegetable substances, or the organic matter, as it is called, must be modified, for if sewage is allowed to stand in open pools it will undergo a most offensive putrification, and but one drop may transmit typhoid to a whole family. Nature has a very effective way of modifying this organic matter. The forces of decay, which are constantly at work on organic matter of every kind, causing in time its complete reduction, are no others than myriads of bacteria, so small that the imagination of man cannot grasp their size. The septic tank is an apparatus for applying these methods of nature to sewage in such a way that the organic matter in it is reduced and no nuisance results. Confined in a tank and kept reasonably quiet, especially at the surface, sewage in a few weeks becomes covered with a thick scum and the solid matter settles out and forms in a sludge at the bottom of the tank. Both the sludge and the scum are literally alive with a form of bacteria, known as anerobia, or those that live only where no air is found. Some facultative bacteria, or those that can live either with or without air are also present. Particles of the organic matter are continually rising from the sludge to the scum, and falling from the scum to the sludge, and more or less gas is evolved as the bacteria act. This action is very effective and the organic matter is changed into liquid forms, leaving only a small amount of finely divided sediment, resembling the humus matter of the soil. So complete is the action that rags, paper and even bits

of wood seem to completely disappear and after long periods of time there is very little sediment found in the tank.



Septic Tank and Siphon Chamber

FIG. 7

41. **Description of a Septic Tank.** Fig 7 shows a section of a septic tank, for liquification, and a siphon chamber and siphon, for discharging the septic effluent in large intermittent doses. The sewage enters the tank (A) through the inlet pipe (E), which is the end of the house sewer. Here it is subjected to the liquifying action of the bacteria in the tank, after which it passes over the weir (D) into the siphon chamber (B). From here it is discharged by the siphon. The septic tank proper, or the part marked (A) Fig. 7 should be three feet wide, five feet long and five feet deep for taking care of the sewage from four people, and four feet wide, six feet long and five feet deep for the sewage from eight people. The depth of the liquid in the tank should be four feet. The lower inside line of the inlet pipe (E) should be one foot below the lower edge of the tank roof, and this pipe should turn downward with an elbow for the discharge of the sewage below the surface of the liquid in the tank. The bottom and walls of the tank should be 7" thick if constructed of concrete, composed of one part cement to three parts sand to five parts crushed rock. The top should be 6" thick and reinforced with any standard mesh reinforcement, or ¼" steel rods, or strands of barbed wire, spaced three inches apart, and ¾" from the bottom of the slab, and run-

ning both lengthwise and across the tank. A manhole should be left for cleaning. A cover (G) for this may be made of concrete poured into a square hole with tapered sides, previously left in the roof when the latter was poured. Before pouring the cover however, the sides of the hole should be well greased or covered with oiled paper, so that the concrete of the cover will not form a bond with the sides of the hole. A ¼" circular iron handle should be built into this cover. The baffles (C) (C) should be 5" thick and reinforced with two ¼" iron rods or strands of barbed wire, near the bottom of each, on each side, and one or two others about half way up. These baffles are for the purpose of reducing the disturbance caused by inflowing sewage and to hold the surface scum within the tank. The one at the entrance end is placed 1½ feet from the inside of the wall of the tank and the other about a foot from the inside edge of the outlet weir. They should be extended into the liquid about one foot. The top of the outlet weir (D) is sharp and one foot below the inside top of the tank. This extends entirely across the tank, and its upper edge is level so that the liquid flows over it in a thin sheet without causing any disturbance in the basin of the tank.

42. **Siphon Chamber.** The siphon chamber (B), Fig. 7, should be built as a continuation of the tank and should have a manhole, with a removable cover (H) built as explained in paragraph (41). This chamber should be three feet wide, two feet, seven inches deep and two feet long, inside dimensions. The liquid enters this chamber over the wall or weir (D). The siphon chamber simply retains the more or less irregular discharges of the tank effluent until it reaches a certain height, when it is very rapidly discharged, automatically by the siphon. The discharge being completed the apparatus prevents further outflow until the chamber is filled again. Such distribution of the tank effluent is essential for the reason that if the liquid is allowed to pass into the final absorption system in the same irregular way that it leaves the house, the tiles and surrounding materials will be constantly saturated near their upper ends, but no effluent will reach the lower ends. The best results are obtained when the drains are filled quickly by a dose, as from a siphon, and this quantity is allowed to perculate into the soil slowly and the drains become filled with air. before another dose is applied.

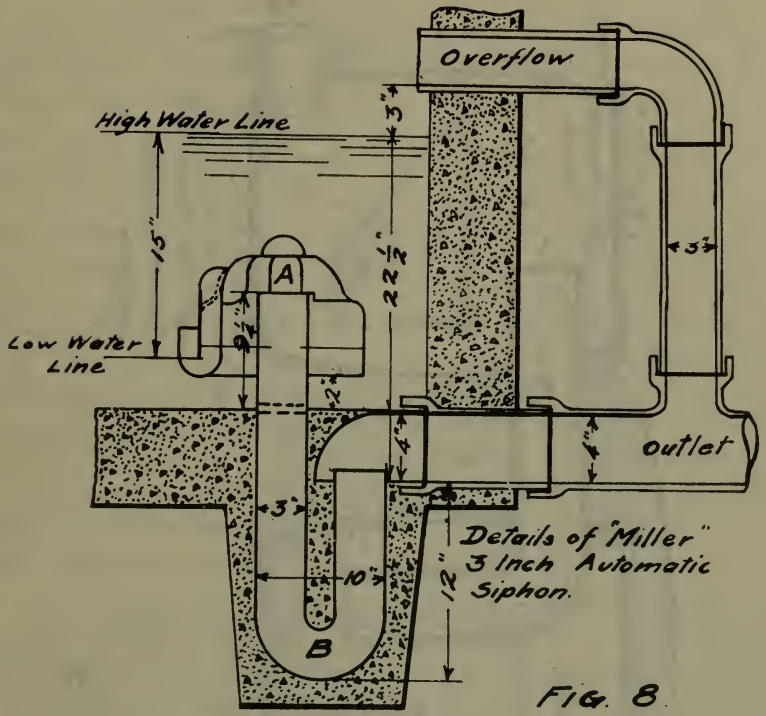


FIG. 8.

43. **Siphon.** Fig. 8 shows the detail dimensions and manner of setting in concrete, a "Miller Three Inch, Automatic Siphon" sold by the Pacific Flush Tank Co. of Chicago, or from "The Hendrie & Bolthoff Mfg. and Supply Co.," of Denver, Colo.

A three inch siphon has a four inch outlet and is amply sufficient in size for a single residence sewage system. The principle of action is as follows. As the siphon chamber begins to fill and the surface of the liquid rises beyond the lower edge of the bell (A) Fig. 8, of the siphon, the air in this bell is trapped. As the level continues to rise the pressure against the confined air increases. Thus the water seal of the curved part, or trap (B) of the pipe is forced downward until the air in the long leg escapes around the curve. This immediately starts the siphonage, the pressure being removed, and the liquid in the siphon chamber begins to flow into the bell and out through the outlet pipe. It will continue to flow until the level of the water in the siphon chamber descends to the lower edge of the bell, when air is sucked under and the flow stopped. There will be a seal of water remaining at the bottom of the curved pipe for the air to press against as the water in the siphon chamber again commences to rise.

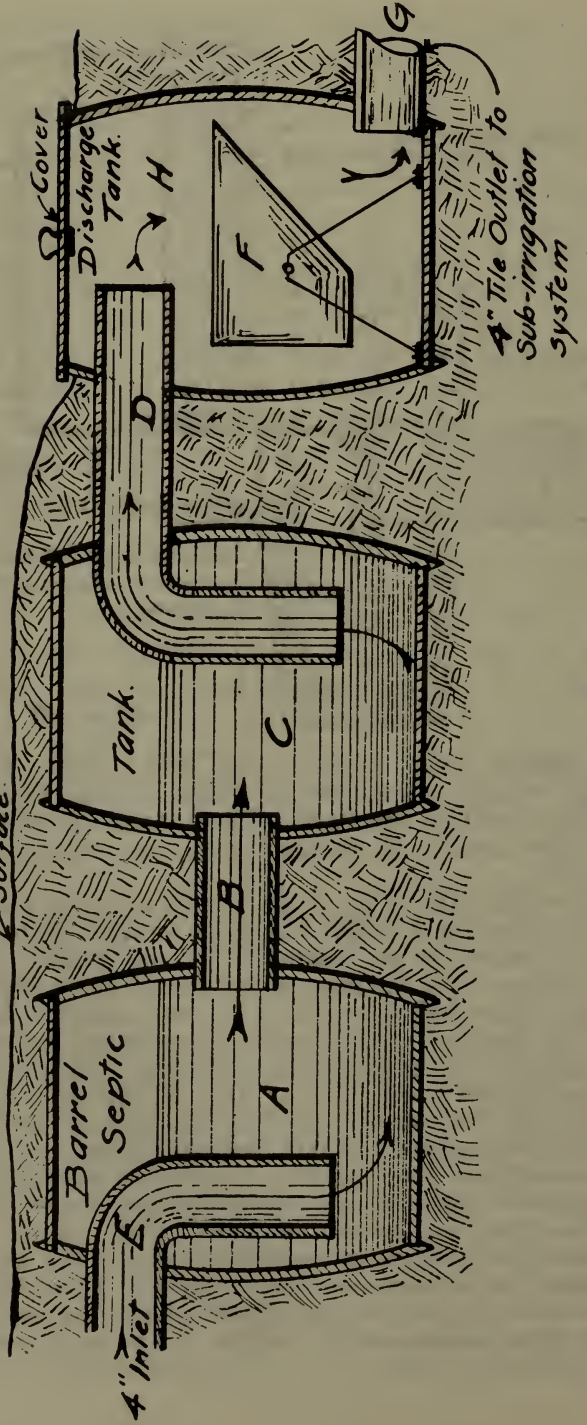

Cover
Discharge Tank.
H
G
F
4" Tile Outlet to Sub-irrigation System
Surface.
Tank.
D
C
B
A
Barrel Septic
4" Inlet

FIG. 9

44. **A Barrel Septic Tank.** A cheap septic tank can be made of two barrels as shown in Fig. 9. The barrels are buried below the ground and connected by a three-inch pipe through their sides. The sewage flows from the end of the house sewer at (E) into the first barrel (A) thence through the connecting pipe (B) into the second barrel (C) and then out through the pipe (D). The inlet and outlet pipes are bent downward into the liquid so that the scum on the surface is not disturbed by the inflowing or outflowing sewage. Three or more barrels can be used for a larger plant. The effluent flows from the pipe (D) into the tipping discharge tank (F) similar to the one discribed in paragraph (36). discharges in turn through the outlet pipe (G) into a sub-irrigation system as described in paragraph (46) and permits the drains to be filled and emptied intermittantly and by this means obtain good results as explained in paragraph (42). The discharge tank (F) is placed in a covered barrel (H) that is accessable from the surface.

45. **Final Treatment Required After Septic Action.** As already stated the septic process should be used in connection with some form of final purification. Septic action simply changes the organic matter from its solid state as found in sewage to a liquid state and these liquids must be subsequently treated to produce the best results. This final treatment may be of several kinds. The septic effluent may be discharged into a system of agricultural tile laid below the surface of the ground. This is called the sub-irrigation system of final purification. It may be distributed into sand and again collected by drains and discharged into a stream or on the surface. This process is known as the Filter Absorption, or Filtration method. A variation of this method is in use, where the liquid effluent is passed down through a well to a natural sand or gravel bed below the surface, if such a bed is available. For small private residences where the conditions are favorable the third method is an excellent one. Ordinarily the sub-irrigation system can be used when the gravel bed is not available, but if the soil is impervious so that the water will not percolate through it, the filtration method must be used. Whatever method is employed the principal is the same, and is simply the oxidation of the organic matter. This might be considered as a kind of slow

burning of the organic matter, as the combining with oxygen is a similar one to that which takes place when matter is reduced by combustion, however this comparison is not a very accurate one.

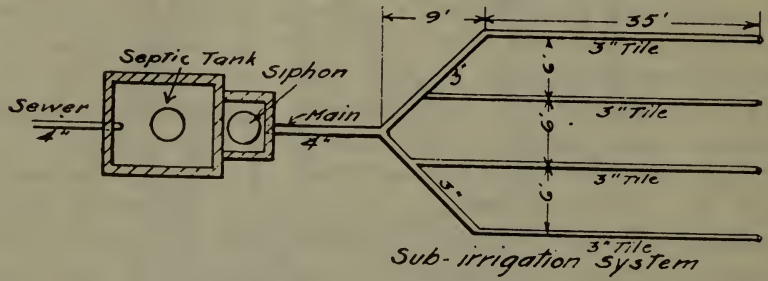


FIG 10

46. **The Single Sub-Irrigation System of Final Purification.** From the siphon chamber the sewage flows through a four inch main into the absorption drains, as shown in Fig. 10. These drains are composed of three inch agricultural tile and each is laid in the center of an eight-inch bed or block of gravel or coarse sand, and about sixteen inches below the surface as shown in Fig. 16. They should be carefully laid, with open joints on a grade of not more than two or three inches to the hundred feet. The joints should be covered with tar paper, or bits of broken tile, to prevent them filling with earth. The tile lines should be placed about six feet apart. Instead of agricultural tile, wooden box drains, open at the bottom, and built of two 2" x 4" and one 2" x 8" piece of lumber, as shown in Fig. 15, may be used if desired. While a system of sub-irrigation disposal drains frequently works for years without giving any trouble, yet they will occasionally become clogged and require cleaning. This is usually an easy job however, as the drains are not laid deep. The area where a sub-irrigation system is to be installed should be selected at a place where the ground water level is the lowest, which will generally be on a bench at the top of a slope. Of course the relative elevation of the ground surface should be low enough to insure a sufficient operating head and fall from the tank to the tiling. If the soil is of a loose gravelly formation or lies over limestone or shale, the location of the area should be selected with a view of pre-

venting contamination of any wells or springs which may exist on the premises, that is to say the area should be below and as far removed from the wells as convenient. Under a lawn or garden is an excellent location for a sub-irrigation system as the moisture is a good aid to the grass or garden truck during dry weather.

47. **The Double Sub-Irrigation System of Final Purification.** The two systems of sub-irrigation drains, each

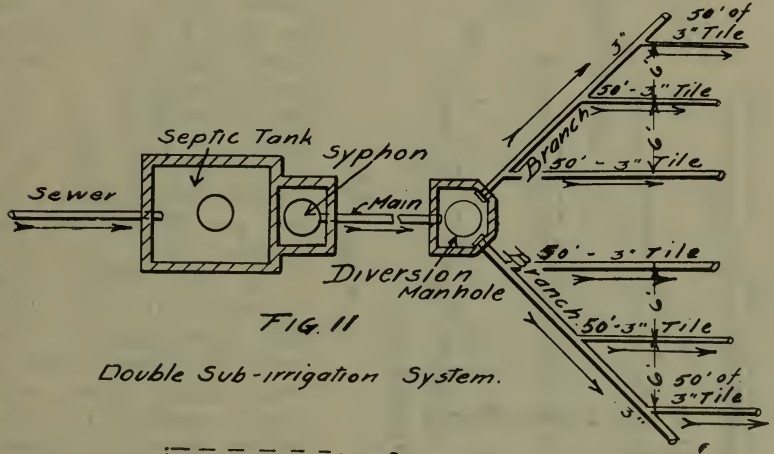


FIG. 11

Double Sub-irrigation System.

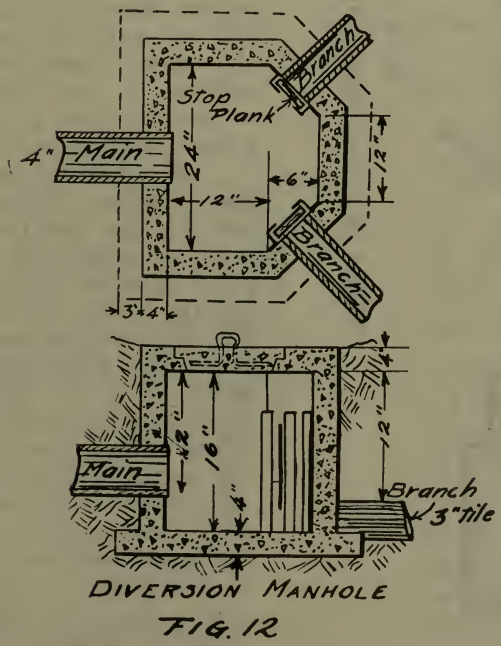
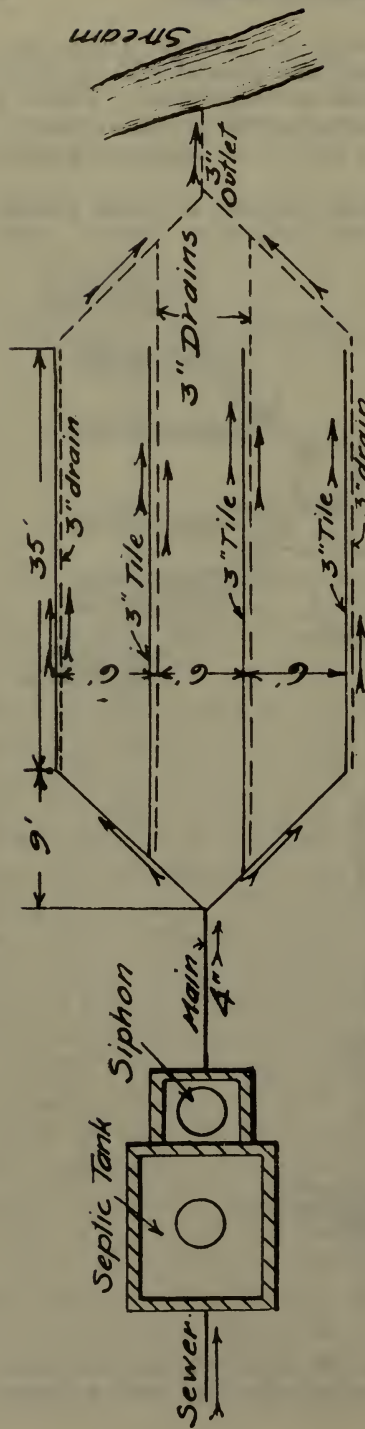


FIG. 12

similar to the one shown in Fig. 10 and described in paragraph (46), may be built as shown in Fig. 11, with a diver-



Filter Absorption System. FIG. 13.

sion manhole, a section and plan of which is shown in Fig. 12. The discharge can be alternated from one system to the other, the time of using each being six or seven days. This can be done by providing some sort of a simple valve, such as a stop plank, sliding up and down in two slots, as shown in Fig. 12.. This double system allows for the purification of one system while the other is in use. While more expensive than the single sub-irrigation system, this double one is very much more efficient, especially in places where there is a great deal of rain, or unusually large quantities of sewage to be disposed of, and the soil is rather heavy and impervious.

48. **Filter Absorption System.** When the soil of the purification area is impervious such as a dobe or clay, the sewage will not percolate into and through it from the sub-irrigation drains and it becomes necessary to construct a filter system to purify the septic effluent. Fig. 13 shows a system of this description. The dosing tile system,which is connected with the main from the siphon chamber, is placed above a drainage tile system. Both sets of tiles are laid in the same trench,

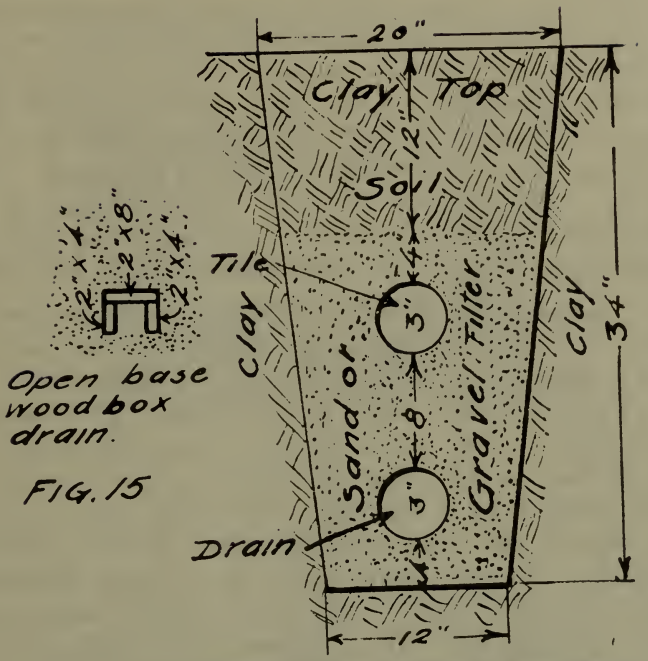


FIG. 15

Filter Absorption System.

FIG. 14.

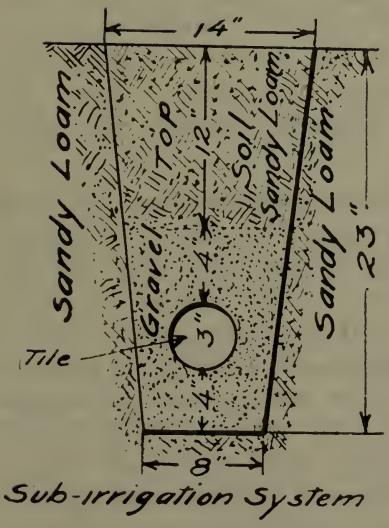


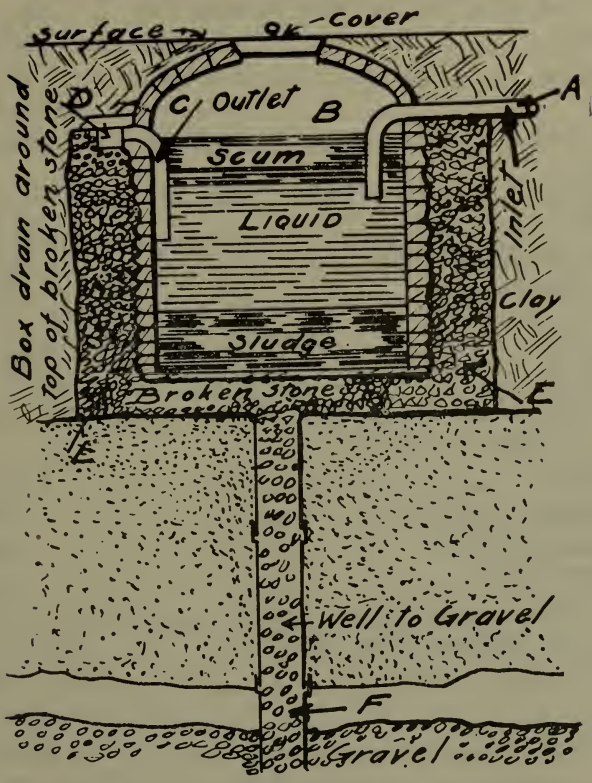
FIG. 16

which is filled to within about twelve inches of the surface with sand or fine gravel. Fig. 14 shows a method of laying these doring and drainage tile. Both systems are built of three-inch agricultural tile and are laid with joints covered with tar paper, or bits of broken pipe. Both systems may be made of bottomless wood box pipe as shown in Fig. 15. The dosing lines are laid about 16

inches below the surface, and the drainage lines about ten or twelve inches below the dosing lines. The lines are placed about six feet part, and the drainage, or lower system, shown by the dotted lines in Fig. 13, must have an outlet into a stream or on the surface of the ground, where it is possible to use the overflow for irrigation purposes. There should be no opportunity for the septic effluent to pass directly from the dosing system to the drainage system without percolating through the intermediate gravel or sand.

49. **General Statements in Regard to These Sewerage Systems.** Contrary to the usual opinion it is not necessary to have a septic tank at any considerable distance from the house. There are cases where they are placed just outside of the foundation. The writer knows of one that was placed within six feet of the cellar wall and no objectionable odors or other troubles have resulted. Very little odor is evolved from a tank of this kind especially after the first month of its operation. In fact there should be no more objection to a septic tank than there is to a well covered and properly cared for, garbage pail. If it is necessary to locate the septic tank in the front yard or some other exposed place, a little shrubbery, a flower bed or a clump of trees will form an excellent screen for a part of the same that shows on the surface. Care should be taken that all tanks and house sewers are water tight so that there will be no danger of sewage getting into the surrounding soil and possibly causing trouble. Septic tanks will not freeze and even in very cold weather the sub-irrigation of filtration systems will work efficiently.

50. **Septic Tank Over a Gravel Sub-Stratum.** If there is a bed of gravel beneath the surface but not at too great a depth, the effluent from the septic tank may be discharged directly into it, according to the system shown in Fig. 17. The sewage passes from the house sewer through the inlet (A) into the water tight septic tank (B) where the solids are liquified, and the effluent then passes out through the pipe (C) into the drain box (D), which extends around the tank at the top of the broken stone or gravel, that is used to fill the pit (E). This drain is supplied with holes or openings, so that it will distribute the discharge of effluent, around the top of the gravel or crushed stone in the pit (E).



Septic Tank over Gravel Bed.
FIG. 17

The effluent is carried down through this gravel into the sewer pipe or iron pipe well (F), through which it passes down to the gravel bed below the surface. This bed acts as a filter and oxidizes the effluent. The direction of the underground flow should in no case be from this system toward a well used for drinking purposes, that is closer than one mile, on account of the possibility of contaminating the well.

51. **Estimated Costs of Sanitary Privies and Sewerage Systems.** The cost of a sanitary privy, or of a residential sewage disposal system will vary greatly according to local costs of labor and materials, and the character of the ground where the septic tank and underground system are to be placed. The following estimates are believed to be fair averages for Montana, and of course the actual cost may be higher or lower than these estimates, according to local conditions.

52. Cost of a Dry or Wet System Privy. (Fig. 1).

Building	$8.00	to	$20.00
Container	.50		3.00
Total	$8.50		$23.00

53. Cost of Sanitary Pail. (Fig. 2).

Lumber for stand	$1.00
Labor, building same	2.00
5 Gal. oil, can	.10
Total	$3.10

54. Cost of L. R. S. Privy With Removable Effluent Tank. (Fig. 3).

Building	$ 8.00
Anti-splash apparatus	.25
2 barrels at $2.00	4.00
Effluent tank	1.00
2 Cu. Yds. excavation at $0.50	1.00
Cover for effluent tank barrel	.25
Outlet pipe	.50
Total	$15.00

55. Cost of L. R. S. Privy With Gravel Sub-Stratum. (Fig. 4).

Building	$ 8.00
Anti-splash apparatus	.25
Barrel	2.00
Outlet pipe and drain	1.00
1½Cu. Yds. Excavation at $0.50	.75
10 ft. of well to gravel at $0.40	4.00
Total	$16.00

56. Cost of L. R. S. Privy With Sub-Irrigation. (Fig. 5).

Building			8.00
Anti-splash apparatus			.25
2½ Cu. Yds. excavation	@	$0.50	1.25
1¾ Bbls. Cement	@	$3.60	6.30
¾ Cu. Yds. sand	@	$1.50	1.15
1¼ Cu. Yds. Gravel	@	$1.50	1.90

Labor, building tank	5.00
50 Ft. Sub-irrigation drain @ $0.10	5.00
Discharge tank	3.00
Cover for discharge tank container	.50
Total	$32.35

57. **Cost of Septic Tank With Siphon Chamber (Fig. 7).**

4 People	8 People		4 people	8 people
8 Cu. Yds.	11 Cu. Yds.	Excavation @ $0.50	$ 4.00	$ 5.50
7 Bbls.	9½ Bbls.	Cement @ $3.60	25.20	36.00
3½ Cu. Yds	5 Cu. Yds.	Sand @ $1.50	5.25	7.50
4½ Cu. Yds	6¾ Cu. Yds	Gravel @ $1.50	6.75	10.15
		Reinforcement	1.00	1.25
		3-Inch siphon	18.00	18.00
		Inlet and Outlet tile	2.00	2.00
		Labor	12.00	15.00
		Total	$74.20	$95.40

58. **Cost of Barrel Septic Tank. (Fig. 9).**

3 barrels @ $2.00	$ 6.00
2 Cu. Yds. excavation @ $0.50	1.00
Discharge tank	3.00
Tile for inlet, outlet and between barrels	2.00
Cover for discharge tank barrel	.50
Total	12.50

50. **Cost of Single Sub-Irrigation System. (Fig. 10).**

160 Ft. of 3" tile or wooden drain, laid in gravel back filled (See Fig. 16, and Fig 15) @ $0.20	$32.00

60. **Cost of Double Sub-Irrigation System. (Fig. 11).**

320 Ft. of 3" tile or wooden drain, laid in in gravel and back filled @ $0.20	$64.00
Diversion manhole.	
½ Bbl. Cement @ $3.60	1.80
¼ Cu. Yd. Sand @ $1.50	.40
½ Cu. Yd. Gravel @ $1.50	.75
1 Cu. Yd. Excavation @ $0.50	.50
Labor	5.00
Tile connections and cover	1.00
Total	$73.45

61. **Cost of Filter Absorption System. (Fig. 13).**

160 Ft. of ditch	@ $0.10	$16.00
320 Ft. of tile or wooden box drain, laid in gravel (See Fig. 14)	@ $0.12	38.40
Total		$54.40

62. **Cost of Septic Tank Over Gravel Sub-Stratum. (Fig. 17).**

Concrete tank	$15.00
Excavation	2.00
Well	4.00
Inlet and outlet pipe and drain	2.00
Total	$23.00

63. **Cost of House Sewer and Sewer From Tank to Final Disposing System.**

100 Ft. 4" sewer, laid and back filled @ $.30 $30.00

64. **Cost of Plumbing a House.**

Soil pipe and necessary Y and T connections	$ 15.00	to	$ 30.00
Two sets of laundry tubs	20.00		60.00
Kitchen sink and drain board	7.50		30.00
Bath tub	20.00		200.00
Lavatory (wash basin for bath room)	7.50		40.00
Closet	17.50		75.00
Hot water boiler and all necessary faucets and piping for hot and cold water	20.00		40.00
Totals	$107.50	to	$475.00

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